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A New Actuation System With Simulated Electrocardiogram Signal for MR Elastography

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Elasticity is an important physical attribute of biological tissue. Elasticity of normal tissue can differ significantly with pathological tissue in its stiffness. It is important to develop a clinical viable method to determine and visualize the elasticity of histological tissue. Magnetic resonance (MR) elastography is a promising noninvasive method to quantitatively measure the viscoelastic properties of biological tissue. We developed a new quasi-static actuation system with the spatial modulation of magnetization (SPAMM) imaging pulse sequence. The MR compatible actuation system consists of an ultrasonic motor, a force sensor, motion-transmission mechanism, ECG signal generation, and controller. The high torque ultrasonic motor, USR60-E3 by Shinsei Corporation, Japan, can function well in the magnetic environment. The simulated ECG signal is generated using function generator, and outputted to both MR scanner and controller respectively. SPAMM imaging sequence is utilized to acquire tagging images of the deformed tissue. The actuation is synchronized with the SPAMM sequence via simulated ECG signal. Indentation force is measured by MR compatible force sensor for the subsequent stiffness inversion procedure. Imaging experiments were conducted using this actuation system and a GE SIGNA 1.5T MR scanner. Clear tag-deformed images of agar gel phantom have been acquired. The results demonstrated the feasibility of utilizing SPAMM sequence and the proposed actuation system for tissue characterization. In comparison with dynamic method of MR elastography, this quasi-static method is relatively simple to implement since no motion sensitive gradient or gradient synchronization is required. A limitation of indentation method is the difficulty to obtain significant deformation of tumor inside the liver organ. Since radio frequency (RF) needle is inserted into liver organ during tumor ablation, the proposed system with needle-based actuation making use of this inevitable insertion will be able to intra-operatively image the liver tumor during ablation. The RF needle can directly vibrate the pathological tissue within the liver organ.

A Breakthrough From an Unexpected Corner: Turning an Old Technology Into a Paradigm Shift

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This paper elucidates the history, the design philosophy of innovation and the transformation of an old process-technology into a breakthrough, evidence-based therapy with international medical acceptance, verification of effectiveness as well as the strategic business model employed. Pulsed electromagnetic field therapy (PEMFT) was not medically acceptable and was, until recently in disrepute, professionally speaking. A revisiting of the technology with reference to the partially inconsistent, yet positive anecdotal results obtained, gave rise to in-depth analysis as well as scientific research conducted by independent institutions which resulted in the identification of the key physiological parameters which in turn could be related to a significant improvement of pathologies. By applying and promoting a systems approach as practiced by engineers who were involved in complex multidisciplinary projects for many years, a different perspective on the innovative development of PEMF therapy was established. The innovative process-based therapy working mainly at cellular and self-regulation level was a paradigmatic departure from the indication-based therapy as applied to pharmaceutical therapy. Over the past 10 years exceptional breakthroughs of the nonsymptom based therapy have been documented through clinical trials, scientific medical investigations and the publication of relevant literature. The turn-around of the old and insufficiently understood technology into an innovative, significant, scientific breakthrough-technology, requires a paradigm shift which is analogous to working in a different culture. It is surmised that this paradigm shift will strongly influence medical schools and practitioners over the next 5–10 years. The authors, as "outsiders" to the medical discipline, bring an engineering perspective to bear on the development of innovative but system-integrated medical devices which can promote the medical device industry and bring system engineering approaches into the realm of medical technology and therapy. Both authors have presented a number of papers at international conferences individually and in partnership on the topics of strategic business leadership and business transformation, system thinking and holistic management model development for high technology companies.

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